Study Title: ENVIRONMENTAL SURVEY OF IDENTIFIED SAND RESOURCE AREAS OFFSHORE ALABAMA
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Project Manager: Mark R. Byrnes, Ph.D.
Affiliation (Project Manager): Applied Coastal Research and Engineering, Inc.
Address: 766 Falmouth Road, Mashpee, MA 02649 (Applied Coastal)
Principal Investigators: Mark R. Byrnes, Ph.D.; Richard M. Hammer, Ph.D.
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Background: The Geological Survey of Alabama characterized five sand resource areas in Federal waters offshore Alabama as potential borrow sites for beach nourishment. The main purpose of this study was to address environmental concerns associated with dredging sand from these Outer Continental Shelf (OCS) sites.
Objectives: Provide MMS environmental information to assess the potential impacts of offshore dredging activities and to identify ways in which dredging operation can be conducted so as to minimize or preclude long-term adverse impacts to the environment. The primary environmental concerns focused on biological and physical components. Seven study objectives were identified: 1) compile and analyze existing oceanographic literature and data sets to develop an understanding of existing environmental conditions offshore Alabama and ramifications of dredging operations at selected sand borrow sites; 2) design and conduct biological and physical field data collection efforts to supplement existing resources; 3) analyze the physical and biological field data sets to address basic environmental concerns regarding potential sand dredging operations; 4) use physical processes data sets to predict wave transformation under natural conditions and in the presence of proposed dredging activities; 5) determine existing coastal and nearshore sediment transport patterns using historical data sets, and predict future changes resulting from proposed sand dredging operations; 6) evaluate potential cumulative environmental effects of multiple dredging scenarios; and 7) develop a document summarizing the information generated to assist with decisions concerning preparation of an Environmental Assessment/Impact Statement to support a negotiated agreement.
Description: The inshore portion of the OCS, seaward of the Federal-State boundary and within the Alabama Exclusive Economic Zone (EEZ), encompasses the project area (Figure 1). The seaward limit of the study area is defined by the 30°05'N latitude line. The project area is located within the east Louisiana-Mississippi-Alabama Shelf (ELMAS). The continental shelf surface within the study area is relatively broad and featureless west of the Mobile Bay entrance; however, the Alabama shelf east of the entrance channel contains many northwest-southeast trending shoreface sand ridges, as well as other shoals (Figure 1).

Five potential sand resource areas were defined within the study area. Of these, a borrow site within each of Sand Resource Areas 1 through 4 was defined to evaluate potential impacts of sand mining for beach replenishment. Physical processes and biological data were collected and analyzed to assess the potential impacts of offshore dredging activities within the study area to minimize or preclude long-term adverse environmental impacts at potential borrow sites and along the coastline landward of resource areas. In addition, wave transformation and sediment transport numerical modeling were employed to simulate physical environmental effects of proposed sand dredging operations to ensure that offshore sand resources are developed in an environmentally sound manner.

Five primary study elements were developed for addressing environmental concerns associated with offshore sand dredging for beach replenishment. They included 1) assess baseline benthic ecological conditions, using existing data sets and data collected from field work, in and around the proposed sand borrow sites; 2) evaluate benthic infauna present in the proposed sand resource areas, and assess the potential effects of offshore sand dredging on these organisms; 3) develop a schedule of best and worst times for offshore sand dredging in relation to transitory pelagic species; 4) evaluate potential modifications to waves that propagate within the study area due to offshore sand dredging within the proposed sand resource areas; and 5) evaluate the impact of offshore dredging and consequent beach replenishment in terms of potential alteration to sediment transport patterns, sedimentary environments, and impacts to local shoreline processes.

Significant Conclusions: Potentially rapid and significant changes in bathymetry due to sand extraction from the OCS may have substantial impact on wave propagation patterns on the continental shelf and at the shoreline. As such, substantial effort was spent understanding existing wave propagation patterns relative to those resulting from potential sand extraction scenarios. For seasonal wave transformation simulations, significant wave heights and wave angles experience little variation to the 15-m depth contour where the wave field begins to feel the influence of bathymetry. Seaward of Dauphin Island, wave heights are relatively consistent along the shoreline while the eastern end of the island is protected from significant wave energy by Pelican Island (subaerial portion of the ebb-tidal delta) and subaqueous shoals associated with the ebb delta. Several areas of wave convergence were identified from the Dauphin Island simulations, including those associated with the Mobile Outer Mound disposal site, which focuses wave energy near Pelican Island during most seasons. Areas of wave convergence and divergence along Morgan Peninsula are primarily caused by southwest-oriented shoals on the continental shelf. For the 50-yr storm simulation, wave patterns are similar to normal seasonal results. However, an increase in wave height is significant in many areas where wave convergence occurs.

Similar results (as those shown for existing conditions) were illustrated for post-dredging simulations. At Dauphin Island, maximum wave height differences for seasonal simulations ranged from ±0.02 to 0.2 m. These maximum changes dissipate relatively rapidly as waves break and advance towards the coast. Along the Morgan Peninsula, maximum wave height differences were slightly larger ("0.2 to 0.4 m) due to borrow site sizes and orientations, as well as their proximity to the shoreline. However, wave energy is dissipated as waves propagate toward the shoreline, and increases in wave height of 0.1 m or less are observed at the potential impact areas along the coast. Overall, the physical environmental impact caused by offshore sand extraction during seasonal and storm simulations is minimal.

Three independent sediment transport analyses were completed to evaluate impacts due to sand mining. They included quantifying historical sediment transport trends using historical bathymetry data sets; documenting sediment transport patterns at proposed offshore borrow sites using wave modeling results and current measurements; and modeling nearshore currents and sediment transport using wave modeling output to document potential impacts to the longshore sand transport system (beach erosion and accretion).

Initially, sediment transport at borrow sites will experience significant changes after sand dredging activities. Sediment that replaces the dredged material will fluctuate based on location, time of dredging, and storm characteristics following dredging episodes. Borrow sites in Sand Resource Areas 1, 2, and 3 are expected to fill with the same material that was excavated (beach sand). The potential borrow site at Area 4, however, will likely fill with fine sediment (i.e., fine sand to clay) exiting Mobile Bay by natural processes or human activities (maintenance channel dredging and disposal). Potential impacts of dredging in Area 4 on littoral transport rates are minimal in relation to Areas 1, 2, and 3. Average annual conditions indicate a relatively high percentage change in transport rates along the eastern portion of Dauphin Island; however, the existing net littoral drift is almost non-existent at this location.

Results of the biological field surveys in the five sand resource areas agreed well with previous descriptions of benthic assemblages residing in shallow waters off the Alabama coast. Potential benthic effects from dredging will result from sediment removal, suspension/dispersion, and deposition. Potential effects are expected to be short-term and localized. Recolonization of Areas 1, 2, and 3 east of Mobile Bay likely will occur in a timely manner and without persistent inhabitation by transitional assemblages. Area 4 infaunal assemblages can be expected to recover more quickly than those in the eastern areas. Because of the physical environmental characteristics of Area 4, especially outflow of fresh water and fine sediment (silts and organics) from Mobile Bay, existing assemblages are comprised of species that colonize perturbed habitats.

Zooplankton, squids, fishes, sea turtles, and marine mammals were groups in the pelagic environment considered to be potentially affected by offshore dredging. No cumulative effects to any of these pelagic groups are expected from individual or multiple sand mining operations.

Study Results: Minimal physical environmental impacts due to potential sand dredging operations have been identified through wave and sediment transport simulations. However, under normal wave conditions, the maximum change in sand transport dynamics is about 5% of existing conditions. Because wave and sediment transport predictions are only reliable to within about ±25%, predicted changes are not deemed significant. Although changes during storm conditions illustrate greater variation, the ability of models to predict storm wave transformation and resultant sediment transport is less certain.

The data collected, analyses performed, and simulations conducted for this study indicate that proposed sand dredging at sites evaluated on the OCS should have minimal environmental impact on fluid and sediment dynamics and biological communities. Short-term impacts to benthic communities are expected due to the physical removal of borrow material, but the potential for significant cumulative benthic impacts is remote. Additionally, no cumulative effects to any of the pelagic groups or physical processes are expected from potential sand mining operations.

Study Products: Byrnes, M.R., R.M. Hammer, B.A. Vittor, J.S. Ramsey, D.B. Snyder, K.F. Bosma, J.D. Wood, T.D. Thibaut, N.W. Phillips, 1999. Environmental Survey of Identified Sand Resource Areas Offshore Alabama: Volume I: Main Text, Volume II: Appendices. A final report for the U.S. Department of Interior, Minerals Management Service, International Activities and Marine Minerals Division (INTERMAR), Herndon, VA. OCS Report MMS 99-0052, 326 pp. + 132 pp. appendices.

[*] P.I.’s affiliation may be different than that listed for Project Manager.

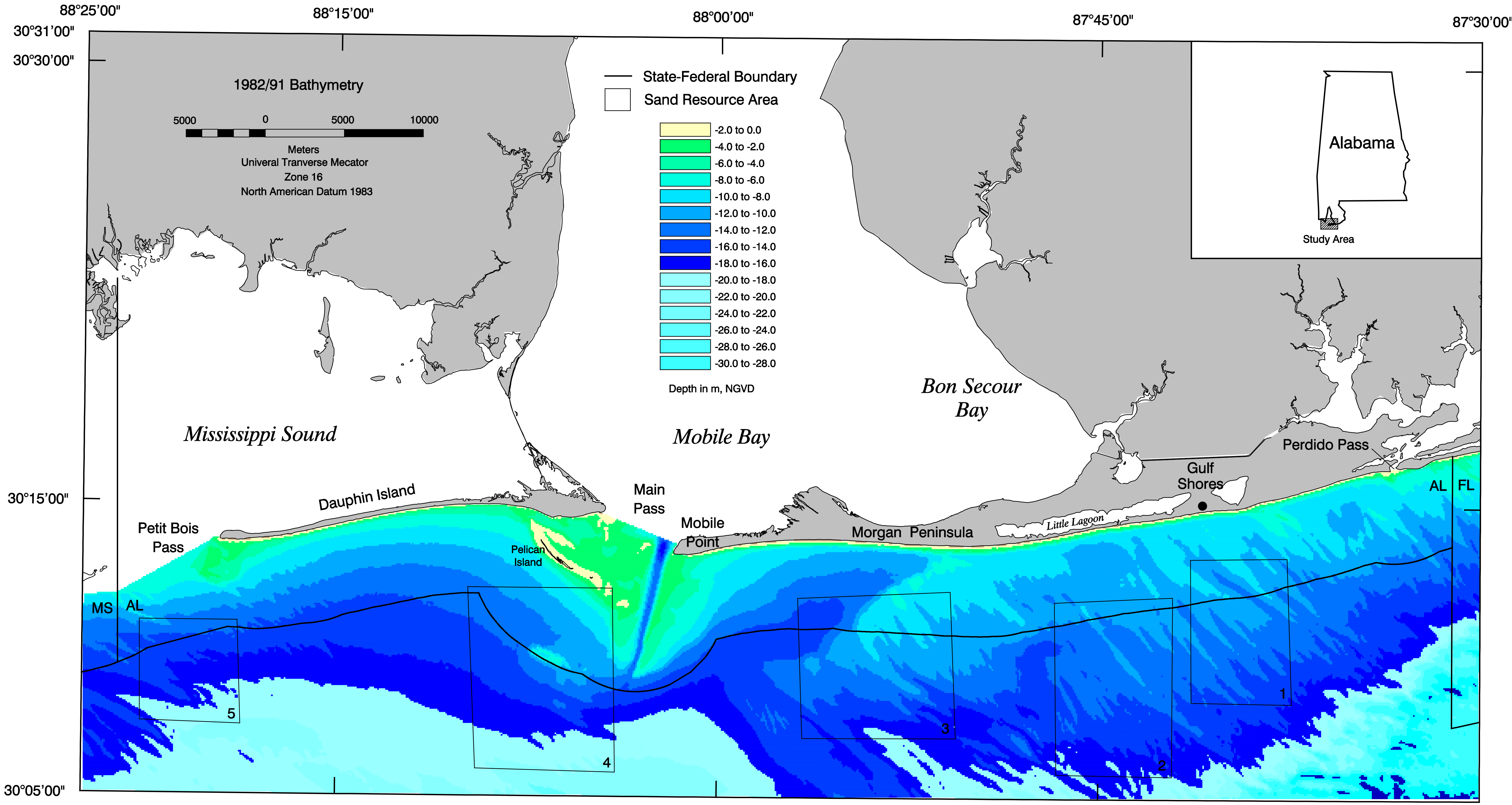

Figure 1. Location of Alabama study area and potential sand resource sites.